



**2003 AFCEE Technology Transfer Workshop**

San Antonio, Texas

*Promoting Readiness through Environmental Stewardship*

# **Bioremediation of MTBE Utilizing Permeable Reactive Barrier Technology**

**3-Year ESTCP Demonstration  
at Port Hueneme, CA**

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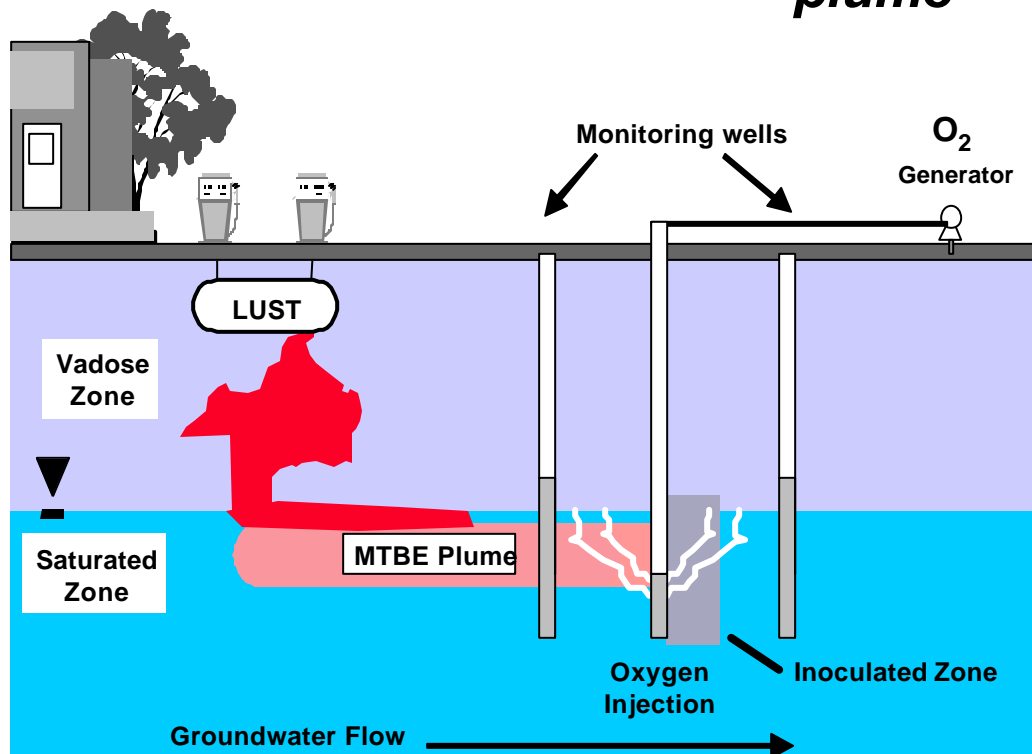


# PRB Technology Overview

Treatment of MTBE-contaminated aquifers through:

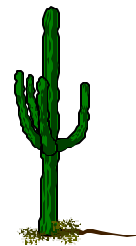
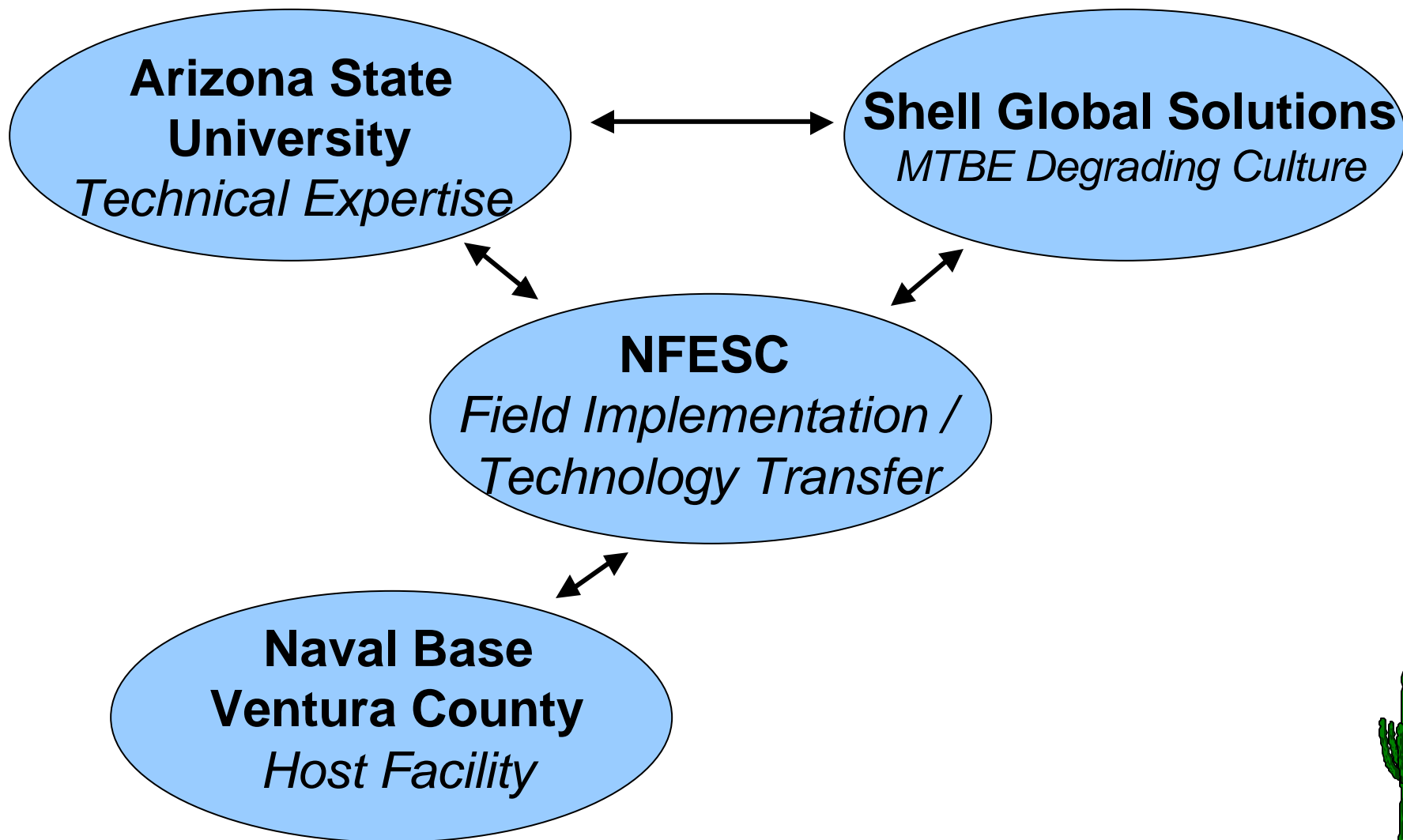
- inoculation with MTBE-degrading organisms (MC-100 and SC-100)
- aeration/oxygenation of the aquifer

*Apply PRB technology to a mixed MTBE-BTEX dissolved plume*



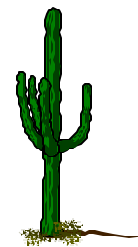
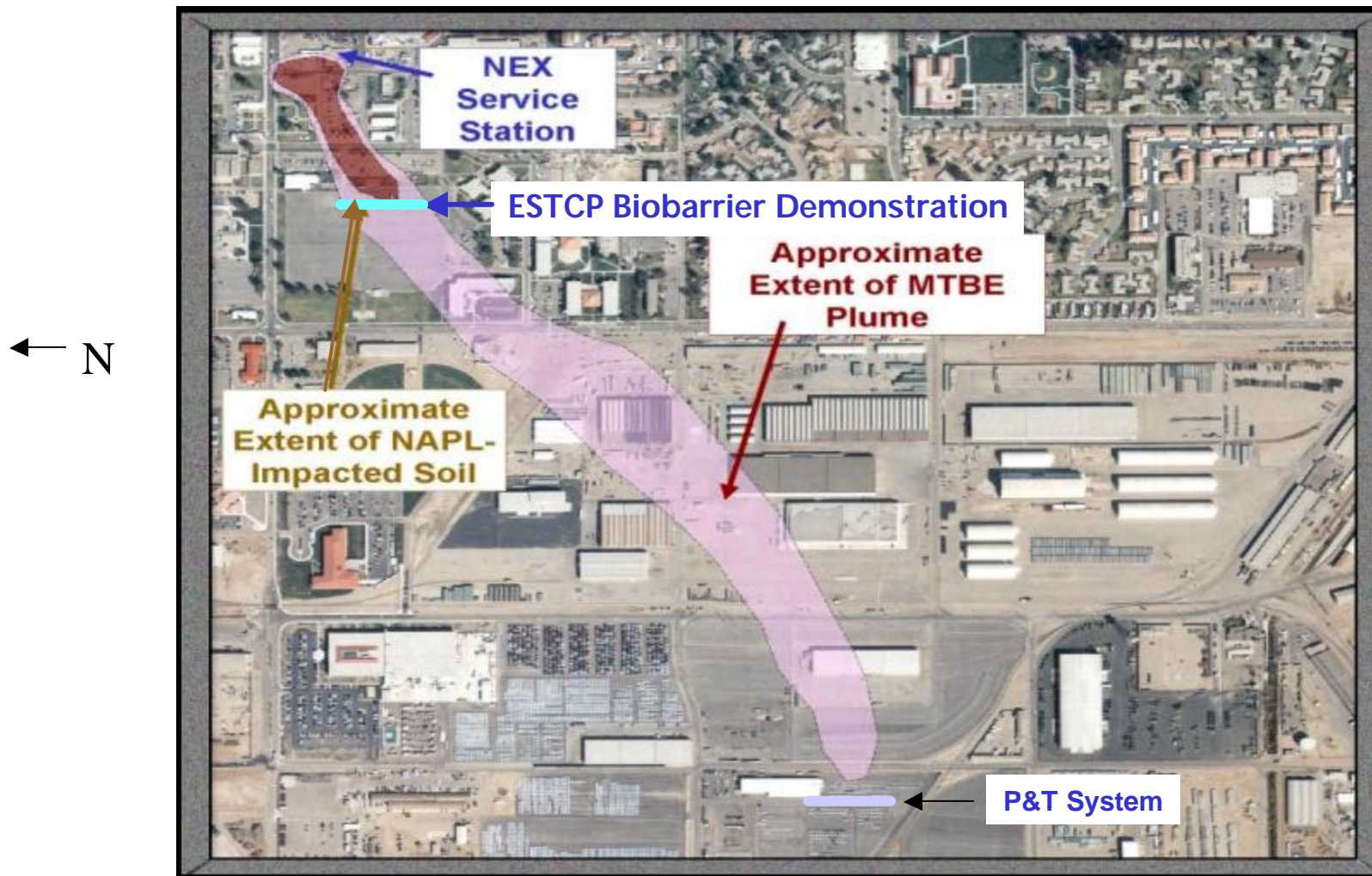


# ***ESTCP Biobarrier Team***





# NBVC, Port Hueneme, CA





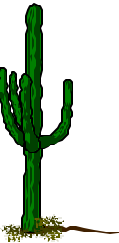


# ***Demonstration System Design***

- Treatment system must not alter the natural flow path
- Modular and flexible with respect to operating conditions.

## Design:

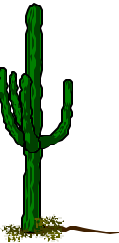
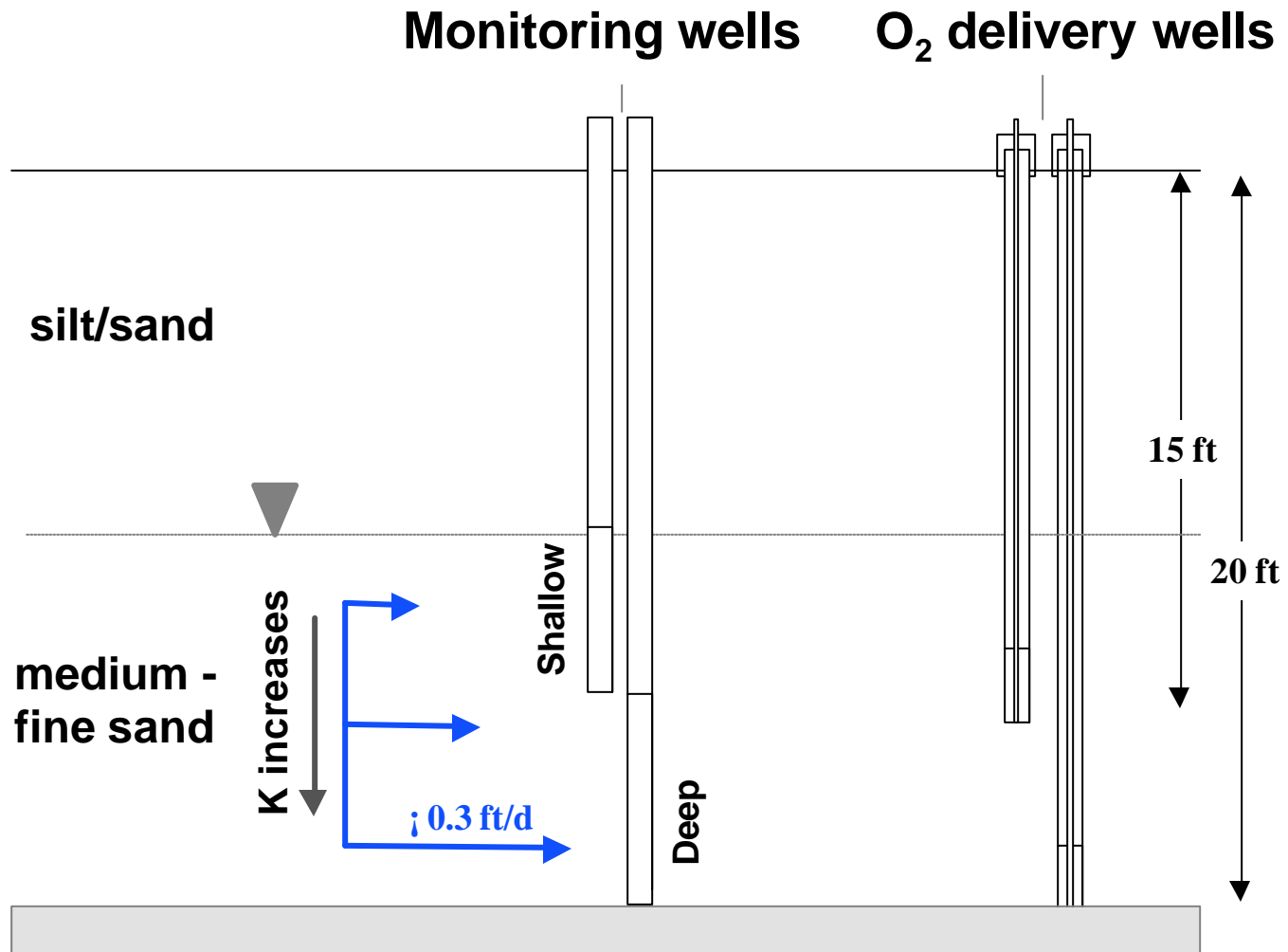
- Close well spacing
- Injection at two depths
- Pulsed gas injection (air and O<sub>2</sub>) [trapped gas continues to supply oxygen for days after injection]





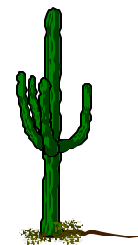
# PRB Subsurface Features

## Subsurface Features





# ***Well Installation, August 2000***



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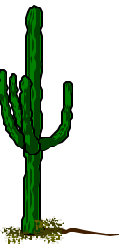


# ***PRB Installation, August 2000***



- 252 air / O<sub>2</sub> injection wells
- 174 monitoring wells

- 500 ft wide Biobarrier





## Section

Air Only

Oxygen Only

MC-100 & Oxygen

SC-100 & Oxygen

Oxygen Only

Air Only

## Footage

0 – 120 ft

120 – 220 ft

220 – 290 ft

290 - 360 ft

360 - 410 ft

410 – 500 ft

SC-100 &  
Air

Air  
Air

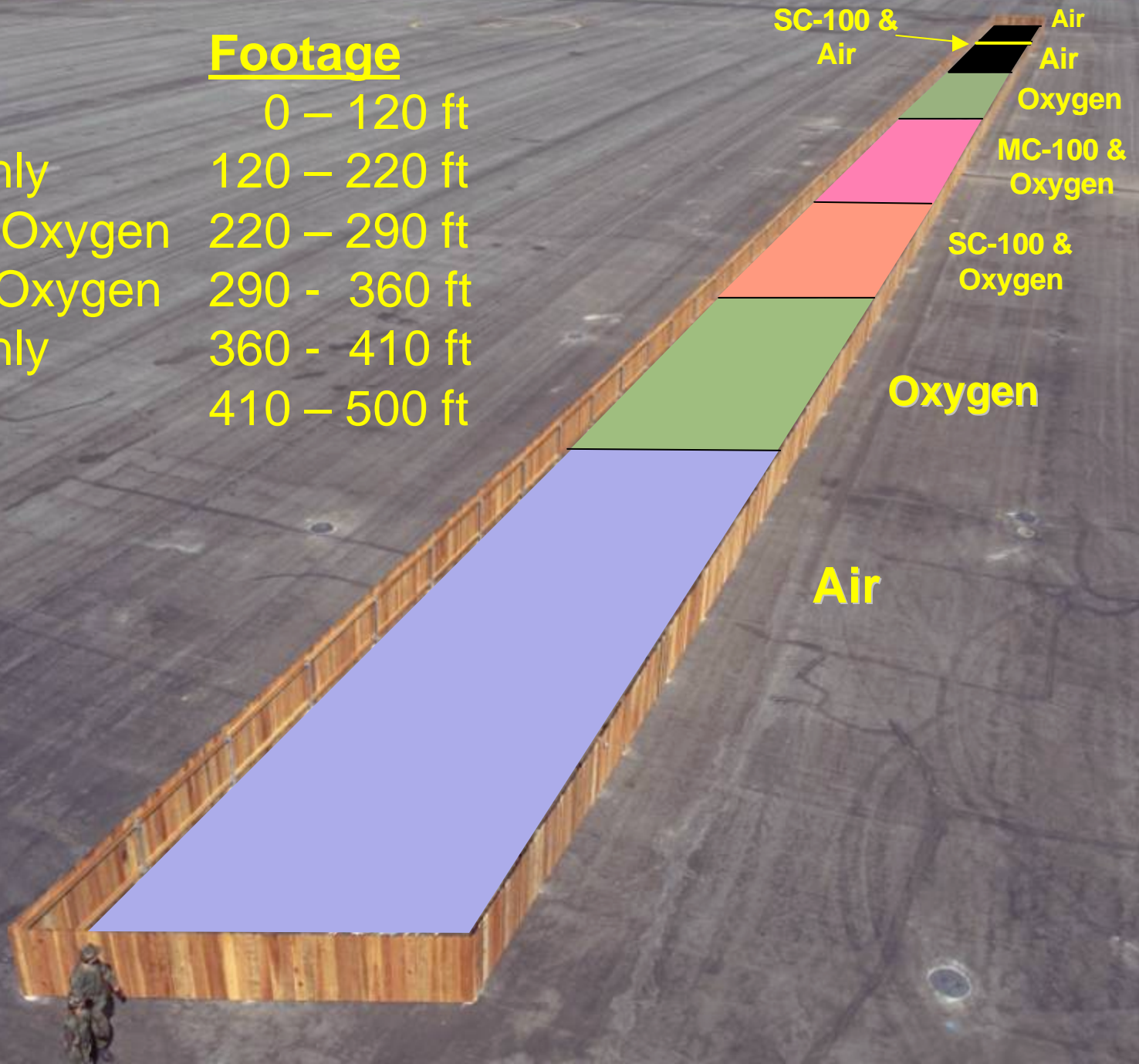
Oxygen

MC-100 &  
Oxygen

SC-100 &  
Oxygen

Oxygen

Air



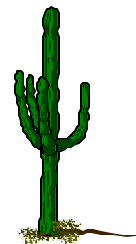




# ***Microbial Inoculation***

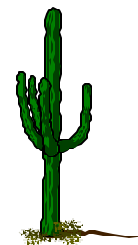
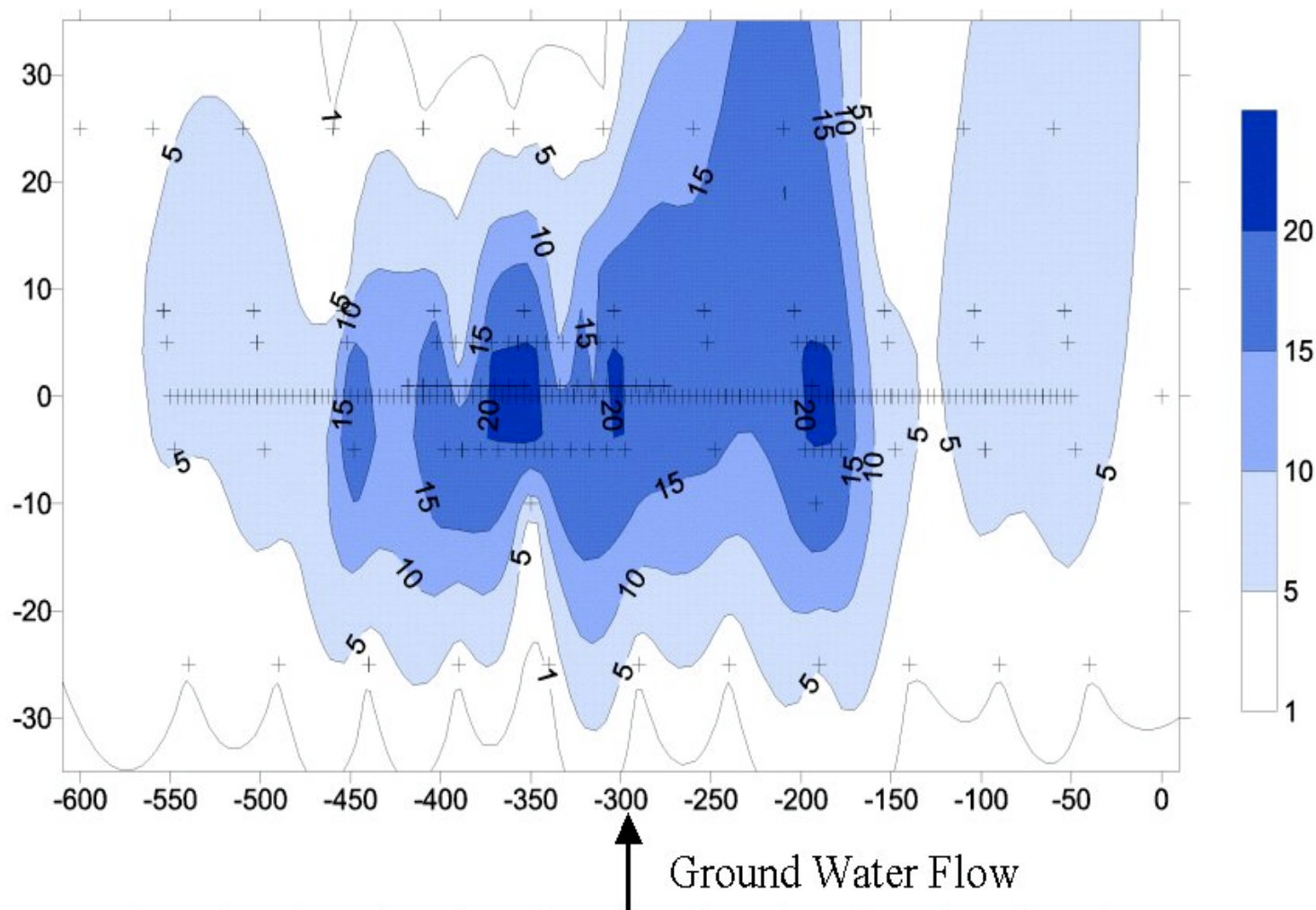


Seeded 165 feet of the BioBarrier with MTBE degrading cultures from Shell Global Solutions.



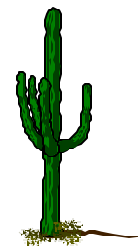
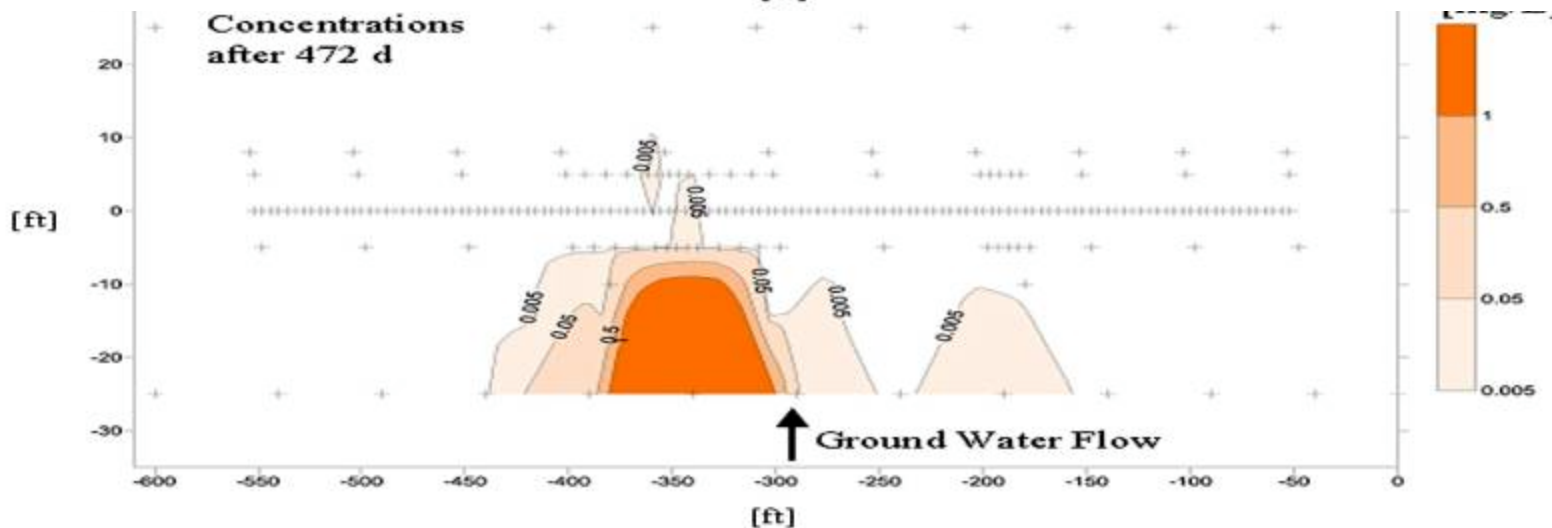
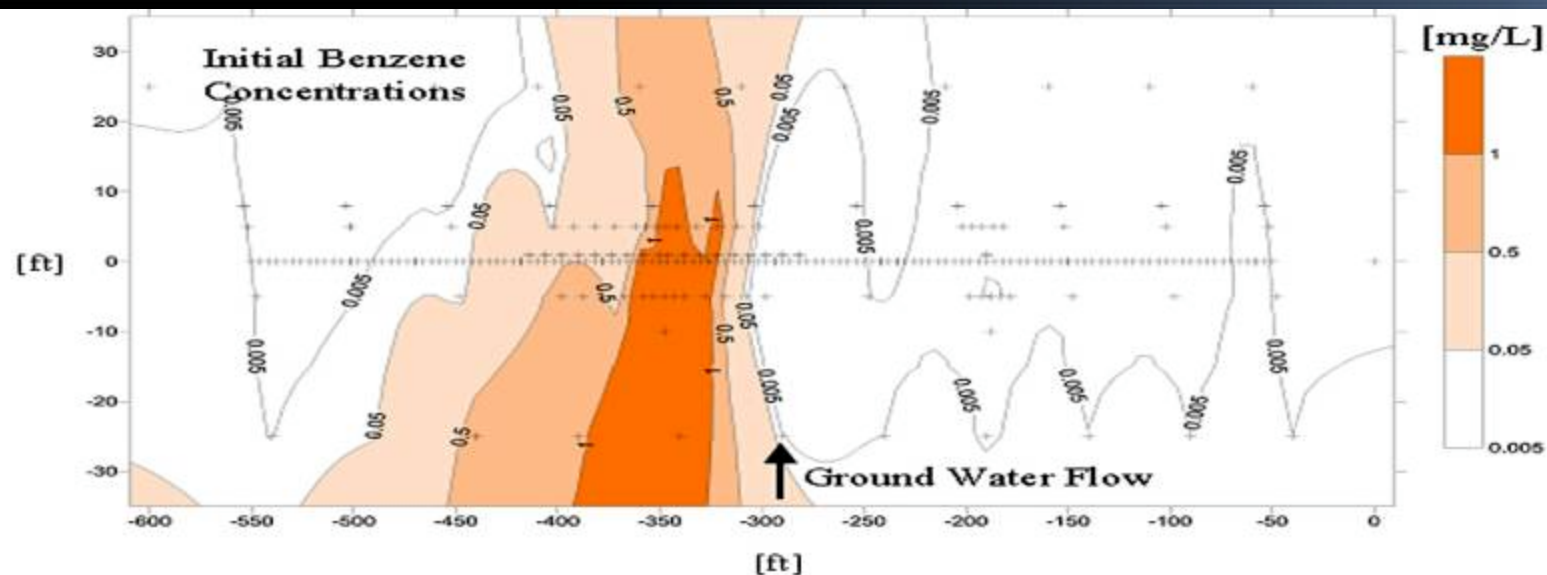


# ***Dissolved Oxygen Distribution***



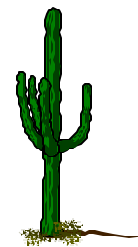
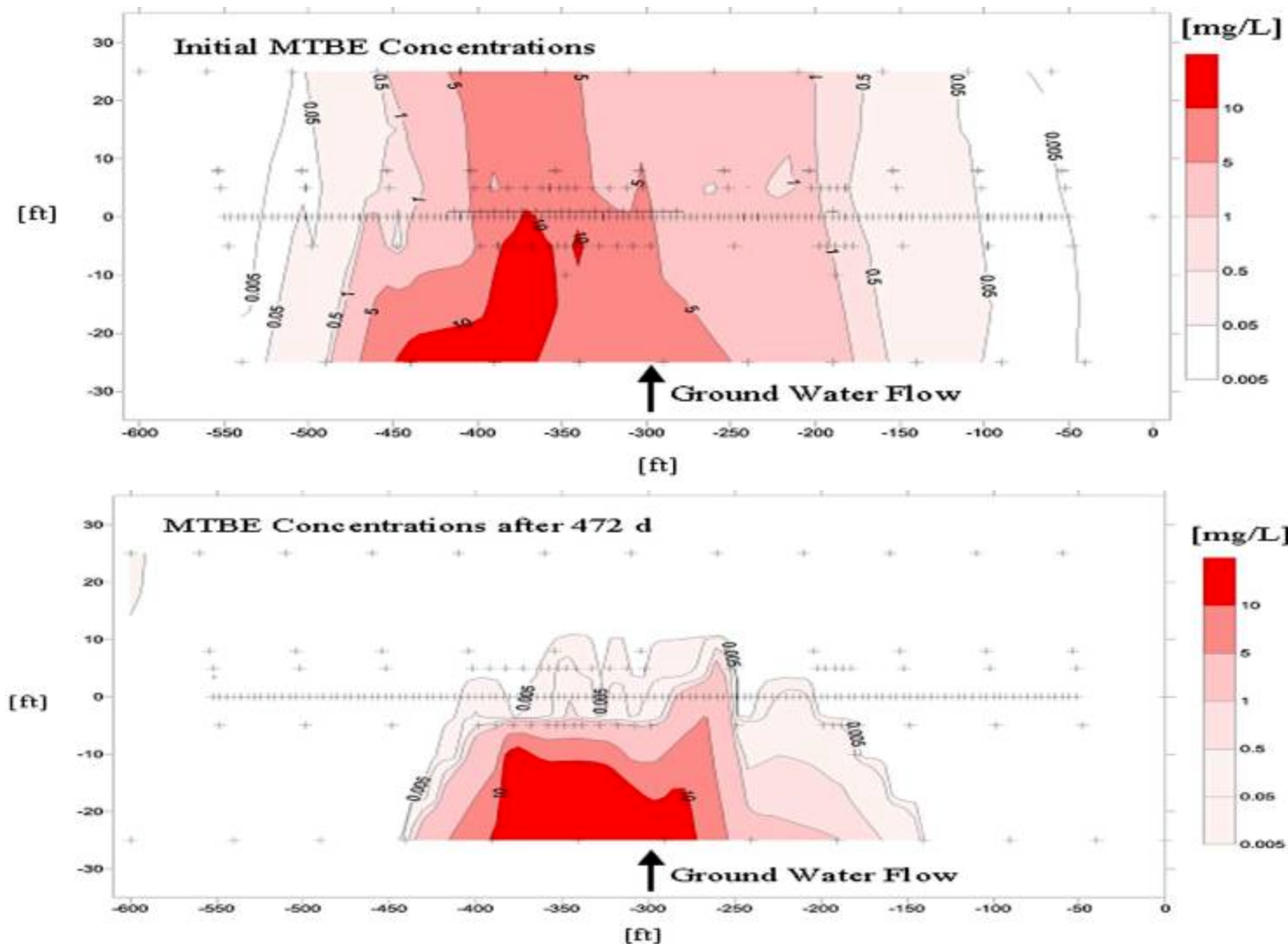


# Benzene Concentrations





# MTBE Concentrations

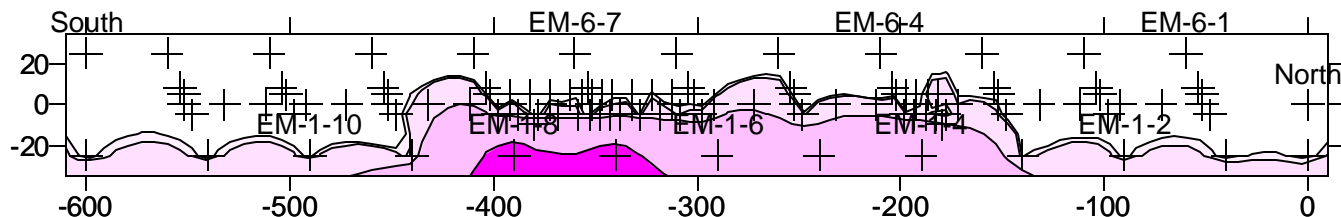




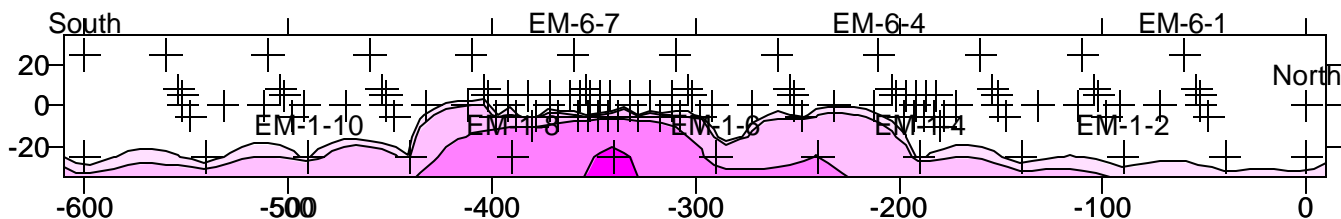


# TBA Concentrations

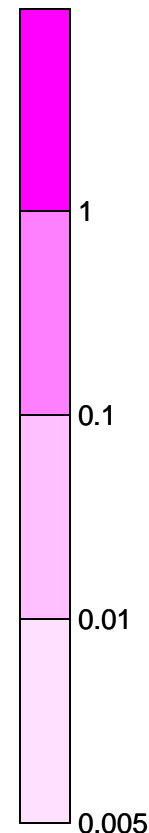
March 2002



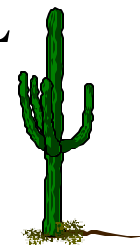
October 2002



Groundwater flow



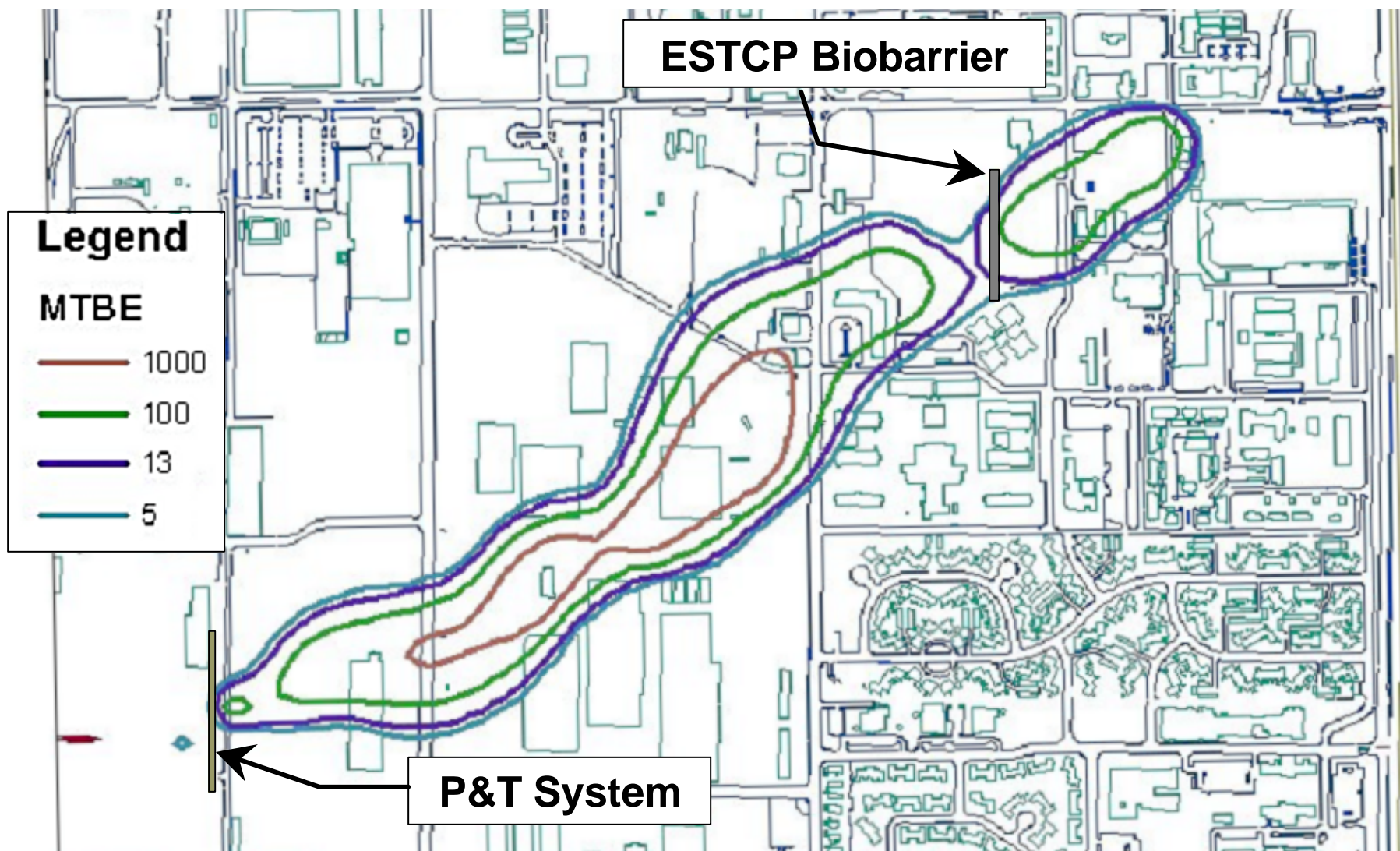
mg/L







# NBVC MTBE Plume Isoconcentration Contour, October 2002 (ug/L)





# ***Final Remedy Options for NBVC***



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# ***Operate P&T System / Remove Biobarrier System***

- **O&M Costs:**
  - FY02 O&M: \$225K/year
  - Life Cycle O&M /Life:  
\$54M / 240 years
- **Advantage:**
  - P&T at leading edge of plume
- **Issues:**
  - High O&M/long service life
  - Disposes 1 million gallons to sanitary sewer annually
  - Est. 200 years to capture 200 gallons of MTBE between biobarrier and P&T





# ***Remove P&T System / Operate Biobarrier System***

- **O&M Costs:**
  - FY02 O&M: \$75K/year
  - Life Cycle O&M /Service:  
\$3M / 40 years
- **Advantage:**
  - Low O&M costs
  - Complete mineralization of MTBE to CO<sub>2</sub> and water
- **Issues:**
  - 200 gallons of MTBE down gradient of biobarrier.
  - Model predicted MTBE may discharge into surface waters.





# ***Convert P&T System / Operate Biobarrier System***

- **O&M Costs:**
  - FY02 O&M: \$125K/year
  - Life Cycle O&M / Life:  
\$20M / 240 years
- **Advantage:**
  - Completely contains MTBE plume
  - Protects against future spills
  - No groundwater or other disposal costs
- **Issues:**
  - P&T conversion: \$300K







# Cost Savings

- Few cost-effective in-situ remedies are known for MTBE impacted aquifers.
- The Navy spends \$10M a year operating and maintaining 24 P&T systems.
- Results from this project show that use of this technology at NBVC alone will lead to a cost savings of over \$30M.





# ***Where's the demonstration going from here...***

- MTBE and BTEX are being degraded to less than 5 ppb across width of the plume
- ESTCP demonstration ended Dec 2002.
- RAP accepted by the Los Angeles Regional Water Quality Control Board designated biobarrier technology as the final remedy for NBVC's MTBE plume

